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The Strategic Use of Private Quality Standards in Food Supply Chains*

Vanessa von Schlippenbach† Isabel Teichmann‡

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Abstract

This paper highlights the strategic role that private quality standards play in food supply chains. Considering two symmetric retailers that are exclusively supplied by a finite number of producers and endogenizing the producers' delivery choice, we show that there exist two asymmetric equilibria in the retailers' quality requirements. The asymmetry is driven by both the retailers' incentive to raise their buyer power and the retailers' competition for suppliers. We find that the use of private quality standards is detrimental to social welfare. A public minimum quality standard can remedy this unfavorable welfare outcome.

JEL-Classification: L15, L42, Q13
Keywords: Private Quality Standards, Vertical Relations, Buyer Power, Food Supply Chain

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1 Introduction

Food scandals, like the British BSE crisis, the melamine found in Chinese milk in 2008 and the dioxin contamination of animal feed in Germany in 2010, are recurrent causes for serious consumer concerns about food quality. In response, both governments and the food industry have tightened food safety regulations. In particular, food retailers have implemented private quality standards, which add to public regulation and do not only cover safety aspects, but also address social and environmental issues. These quality standards clarify product and process specifications, stipulate how these specifications are met and define each trading partner's responsibilities. Thereby, product standards refer to the physical properties of the final products, such as maximum residue levels (MRLs) for pesticides and herbicides, threshold values for additives and requirements for packaging material. Process standards, in turn, relate to properties of the production process, including hygiene, sanitary and pest-control measures, the prohibition of child labor, animal-welfare standards and food quality management systems. Most notably, the quality of fresh fruits, vegetables and meat products is regulated by retailers' private quality standards. Retailers implement private quality standards either individually or collectively. Tesco's Nature's Choice and Carrefour's Filière Qualité are examples of individual private standards, while the British Retail Consortium (BRC) Global Standard for Food Safety and GlobalGAP are collective private standards. Even when adopting collective private standards, retailers tend to supplement them with individual requirements (OECD 2006).[1] Thus, quality standards may vary widely among the individual retailers.[2] Against this background, there is a debate as to whether retailers use private quality standards as a strategic instrument to gain buyer power in procurement markets.[3,4] So far, this conjecture has not been formally analyzed.[5] We intend to narrow this gap with

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[1] In the U.S., for example, collective private standards were first adopted by Wal-Mart on a nation-wide basis in 2008 (Wal-Mart 2008a). In addition, Wal-Mart implemented steps towards reduced packaging by its suppliers (Wal-Mart 2008b) and a more sustainable global supply chain (Wal-Mart 2011).

[2] In Germany, for example, the MRLs for pesticides established by some large retail chains in 2008 ranged from 80% of the public MRL (Aldi, Norma), to 70% (REWE, Edeka, Plus), to as low as 33% (Lidl) (PAN Europe 2008). The British retailer Marks & Spencer plans to have all of its fruit, vegetables and salads free of any pesticide residues by 2020 (Marks & Spencer 2010).

[3] Further incentives for retailers to set private standards might be to prevent potential revenue losses due to reputation (OECD 2006), to respond to public minimum standards (e.g., Valletti 2000; Crampes and Hollander 1995; Ronnen 1991), to pre-empt or influence public regulation (e.g., McCluskey and Winfree 2009; Lutz et al. 2000), to substitute for inadequate public regulation in developing countries (e.g., Marcoul and Veyssiere 2010), or to safeguard against liability claims (e.g., Giraud-Héraud et al. 2006b, 2008).

[4] There is also a strong debate on whether increasing quality requirements by large retailers may impose entry barriers for suppliers in developing countries, in particular for small-scale producers (e.g., OECD 2007, 2006; EC 2006; García Martinez and Poole 2004; Balsevich et al. 2003; Boselie et al. 2003).

[5] Hammoudi et al. (2009) even state that the understanding of the strategic aspects of private quality standards in vertical relations is still underdeveloped.

a theoretical analysis of retailers' quality choice and its implications for market structure and social welfare.

We consider a vertical structure with two independent downstream retailers that are supplied by a finite number of capacity constrained upstream producers. The assumed industry structure reflects the situation in many countries where a relatively large number of suppliers face a highly concentrated retail sector (e.g., Dobson et al. 2003; OECD 2006). We further assume that the upstream production costs are increasing in the quality requirements and the quantity produced. The latter is driven by the assumption that the upstream firms are capacity constrained. The players interact as follows. First, the retailers decide upon their quality requirements. Then, the suppliers choose which quality standard they meet and which retailer they supply. Thereby, compliance with a higher quality standard is associated with higher quality costs.[6] Note that we assume that the suppliers are not able to adjust the quality of their production in the short-term since production costs depend on the underlying production processes.[7] Given the retailers' quality requirements and the suppliers' delivery decision, both retailers enter into bilateral negotiations with their respective suppliers about quantity-forcing tariffs. These consist of the quantity to be delivered by the supplier and a fixed payment to be made by the retailer. If the suppliers fail to find an agreement with their selected retailer, they are able to switch their delivery to the other retailer as long as they comply with the respective quality requirements. In turn, the retailer cannot replace any supplier in the case of negotiation breakdown. Upon successful completion of the negotiations with the selected retailer, the suppliers produce and deliver their products to the retailer. Lastly, the retailers sell the goods to final consumers.

Our results reveal that the retailers use private quality standards to improve their bargaining position in the intermediate goods market. At the same time, our results provide a new explanation for quality differentiation in downstream markets. More precisely, we find that there exist two asymmetric equilibria in the retailers' quality choice where one retailer implements a relatively high quality standard, while the other imposes lower quality requirements. The intuition is as follows. Taking a relatively high quality standard at one retailer as given, the other retailer has an incentive to undercut that retailer's quality requirements to improve its own bargaining position in the intermediate goods market. The reason ist that suppliers complying with the lower quality standard cannot

[6] Production costs in the food sector are increasing in quality due to the necessary replacement of pesticides, herbicides or fertilizer by more expensive raw materials, increased management duties and higher labor inputs. Further quality-related cost increases are associated with the development and implementation of quality-management systems, stricter testing and documentation, changes in the production processes, and certification requirements.

[7] For a detailed justification of this assumption, see Section 2.

switch their delivery to the retailer with the higher quality requirements since they are not able to adjust their products' quality in the short-term. Accordingly, the delivery to that retailer becomes less attractive, such that fewer producers decide to supply that retailer. The lower number of suppliers, however, results in a higher production per supplier and, thus, in higher production costs. The retailer counters this cost effect by further decreasing its quality requirements and, thus, by reducing the quality-related production costs. Furthermore, the delivery to the high-quality retailer becomes less attractive the more the low-quality retailer decreases its quality requirements. That is, the larger the difference in quality standards, the lower the outside option of the suppliers delivering to the high-quality retailer. Taking now a relatively low quality requirement at one retailer as given, the other retailer has an incentive to implement a stricter quality standard than that retailer. By increasing its quality requirements, it improves its bargaining position as the outside option of the suppliers becomes less valuable. We find that the higher quality standard exceeds the socially optimal quality level, while the lower quality standard undercuts the social optimum. Thus, the use of private quality standards is detrimental to social welfare. The negative welfare effects of private quality standards can be softened with the enforcement of a public minimum quality standard (MQS). If the public MQS is binding, the retailer with the lower quality requirements cannot unrestrictedly reduce its quality standards in response to increasing quality requirements of the other retailer. As a consequence, the high-quality retailer has less incentive to increase the quality standard, such that the quality requirements of both the high-quality and the low-quality retailers approach the social optimum.

Our analysis is related to the large theoretical literature on buyer power, which studies the sources of buyer power and its implications for the overall efficiency of vertical relations.[8] Potential sources of buyer power analyzed so far include credible threats to vertically integrate or to support market entry at the upstream level (e.g., Katz 1987; Sheffman and Spiller 1992), potential delisting strategies after downstream mergers (e.g., Inderst and Shaffer 2007) as well as producers' differentiation (Chambolle and Berto Villas-Boas 2010). We show that downstream firms' private quality standards may constitute an additional source of buyer power. With regard to the efficiency effects of buyer power, Inderst and Wey (2003, 2007) point out that the formation of large buyers and, thus, the emergence of buyer power may increase consumer surplus as well as overall welfare since suppliers' investment incentives increase. Montez (2008) shows that an upstream firm may choose higher capacities when buyers merge as long as the costs of capacity are sufficiently low. Negative welfare effects due to increased buyer power are analyzed by Inderst and

[8] For a survey on the sources and consequences of buyer power, see Inderst and Mazarotto (2008) as well as Inderst and Shaffer (2008).

Shaffer (2007). They find that a retail merger can induce the manufacturers to reduce the variety of their products in order to comply with 'average' preferences (see also Chen (2004)). Moreover, Battigalli et al. (2007) derive the result that buyer power weakens a supplier's incentive to invest in quality improvement. We show that buyer power due to private standard setting decreases social welfare.

Although quality standards are receiving growing attention in the theoretical economic literature, few papers address private standards in vertical relations.[9] Among the papers covering private quality standards, Bazoche et al. (2005) and Giraud-Héraud et al. (2006a) analyze individual private standards. Giraud-Héraud et al. (2006a) show that the incentive for a retailer to differentiate its business via a premium private label (PPL) increases as the public MQS is reduced. Bazoche et al. (2005), in turn, analyze the effects of a retailer's PPL for a given level of the public MQS. In their model, the retailer introducing the PPL would choose an intermediate level of the private quality standard to segment the market. Furthermore, Giraud-Héraud et al. (2006b and 2008) study collective standard setting. Both papers analyze the introduction of a collective standard for a given public MQS, assuming that retailers are price takers in the procurement market. In their models, the retailers' incentive to implement a collective standard depends on the existence of a legal liability rule.

The remainder of the paper is organized as follows. In Section 2, we present our model. Section 3 contains the analysis of a benchmark case where none of the suppliers has an outside option. Turning to Section 4, we take into account the above-described outside options for the suppliers and investigate the equilibrium outcomes of the game. In Section 5, we allow for retail competition, conduct social-welfare analysis and study the impact of a public MQS. Finally, we conclude.

2 The Model

We consider a food supply chain with two symmetric downstream retailers D_i, $i = 1, 2$, and $N \geq 2$ symmetric upstream suppliers U_{ij}, $j = 1, ..., N$.[10] We assume that N_1 upstream firms $U_{11}, ..., U_{1N_1}$ produce a homogeneous intermediate good and sell it exclusively to the downstream firm D_1, while the remaining $N_2 = N - N_1$ upstream firms $U_{2N_1+1}, ..., U_{2N}$ manufacture a homogeneous intermediate good and deliver it exclusively to the downstream firm D_2. The retailers transform the received inputs on a one-to-one basis into a

[9] For example, Valletti (2000), Crampes and Hollander (1995) and Ronnen (1991) analyze private standard setting in response to the introduction of a public minimum standard. Focussing on product differentiation, private quality decisions of firms are also studied by Motta (1993) and Gal-Or (1985, 1987), for example. However, all these papers neglect vertical supply structures.

[10] Note that the index i refers to the retailer i the upstream firm U_{ij} delivers to.

single consumer good each. That is, retailer D_1 sells good 1 and retailer D_2 sells good 2. Both retailers operate as local monopolists in two independent markets.[11] This allows us to analyze the quality decision of the retailers abandoning any impact of downstream competition.[12]

Each retailer implements a private quality standard $q_i \in [\underline{q}, \overline{q}]$ with $\underline{q} < \overline{q}$, whereby $\underline{q} \geq 0$ indicates a public MQS. Quality requirements above $\overline{q}$ are not feasible as they may induce extremely high production costs. The suppliers cannot sell their products to the retailers unless they comply with the respective quality standard. Hence, the N_1 upstream firms delivering to retailer D_1 produce at least according to the quality requirements q_1, while the N_2 upstream firms supplying retailer D_2 adhere to the quality standard q_2. We assume that the product quality is observable to all agents, i.e. suppliers, retailers, and consumers.[13]

Demand. Each retailer D_i faces an inverse demand

$$p_i(q_i, X_i) = \max\left\{q_i - X_i, 0\right\}, \ \forall i = 1, 2, \tag{1}$$

where X_i denotes the overall quantity that retailer D_i sells to final consumers. The overall quantity consists of the sum of intermediate inputs delivered by the upstream suppliers, i.e.

$$X_i = \sum_{j=a}^{A} x_{ij} \text{ with: } \begin{cases} a = 1,\ A = N_1 & \text{for } i = 1 \\ a = N_1 + 1,\ A = N & \text{for } i = 2 \end{cases}, \tag{2}$$

where x_{ij} refers to the quantity that supplier U_{ij} sells to the retailer D_i. Furthermore, we assume that the consumer willingness to pay for good i is positively correlated with the respective quality parameter q_i.[14]

Costs. While the retailers' costs of transformation and distribution are normalized to zero, each supplier incurs total costs of $C(x_{ij}, q_i)$ for producing the quantity x_{ij} at the quality level q_i, where $C(0, q_i) = 0$, $C_{x_{ij}}(0, q_i) = 0$ and $\lim_{q_i \to \overline{q}} C(x_{ij}, q_i) = \infty$. The cost functions are twice continuously differentiable, increasing and strictly convex in both x_{ij} and q_i, i.e. for all $x_{ij}, q_i > 0$ it holds that

$$C_\tau(x_{ij}, q_i),\ C_{\tau\tau}(x_{ij}, q_i), C_{x_{ij}q_i}(x_{ij}, q_i) > 0 \text{ with } \tau = x_{ij}, q_i. \tag{3}$$

[11] Local monopolies in retailing may, for example, result from consumers' one-stop shopping preferences.

[12] This assumption will be relaxed in Section 5, where we consider Cournot competition at the downstream level.

[13] Note that the product quality is not necessarily directly communicated to consumers, but consumers might be indirectly informed about the standards through third-party investigations, such as those led by environmental lobby groups.

[14] It is shown, for example, that consumers are willing to pay a premium for eco-labeled food (Bougherara and Combris 2009), for organic products (Gil et al. 2000), for milk quality attributes (Bernard and Bernard 2009; Brooks and Lusk 2010; Kanter et al. 2009), and for beef quality attributes (Gao and Schroeder 2009).

The convexity in quantities reflects decreasing returns to scale and implies that the suppliers are capacity constrained, while the convexity in qualities characterizes a decreasing marginal revenue from quality investments. The adherence to a higher quality standard induces greater production costs because of necessary changes in the production processes (e.g., Codron et al. 2005) and the adoption of different production technologies (e.g., Mayen et al. 2009). In other words, production according to a particular quality standard is associated with investments in specific technologies, production facilities or the implementation of a particular quality-management system. We, therefore, assume that the variable costs of quality cannot be adjusted in the short-term, neither upwards nor downwards, since they at least partly hinge on the production process implemented to fulfill a certain quality standard.[15] Referring to our assumptions, we apply the following cost function [16]

$$C(x_{ij}, q_i) = \frac{q_i^2}{2(\overline{q}^2 - q_i^2)} x_{ij}^2 \text{ for } 0 < q_i \leq \overline{q} = \sqrt{2}. \tag{4}$$

Negotiations. Given the retailers' quality requirements, the upstream firms decide which quality standard they comply with and, thus, which retailer they supply. Before production takes place, each retailer negotiates bilaterally and simultaneously with each of its respective suppliers a delivery contract T_{ij}. Referring to the fact that vertical relations are often based on more complex contracts than simple linear pricing rules (Rey and Vergé 2008), we assume that the delivery contract has the form of a quantity-forcing contract.[17] Such a contract specifies both the quantity x_{ij} that supplier U_{ij} has to deliver to the retailer D_i and the fixed payment F_{ij} that supplier U_{ij} receives from retailer D_i in exchange for the delivery. The delivery contracts are considered to be short-term.[18] Negotiation outcomes are observable to all players. Moreover, both the suppliers and the retailers are fully committed to these contracts. Note that we do not allow for renegotiation in the case of negotiation breakdown between any retailer-supplier pair. If the retailer fails to find an agreement with one supplier, it cannot replace that supplier. This supplier, however, is able to switch its delivery to the other retailer as long as it complies with the respective

[15] For example, improved quality-management systems require higher-skilled personnel as well as more frequent documentation and sampling requirements (Rau and van Tongeren 2009; Preidl and Rau 2006). The decision for a particular inventory method applied to perishable goods is another case in point. While the FIFO (first in, first out) policy is associated with higher variable costs, the LIFO (last in, first out) policy entails lower quality-related variable costs (Reyniers and Tapiero 1995).

[16] This assumed cost function is an approximation of the standard assumption in models of vertical differentiation where production costs are strictly increasing and convex in q_i for $q_i \in [\underline{q}, \overline{q}]$ and are infinitely high for $q_i > \overline{q}$. Moreover, the cost function is *sufficiently* convex in quality for the suppliers' profit functions to be concave in quality (cp. Bazoche et al. 2005).

[17] Note that non-linear tariffs are commonly used in intermediate goods markets. Empirical evidence is provided by Bonnet and Dubois (2010) and Berto Villas-Boas (2007).

[18] This is in accordance with observations that "a large portion of the contracts observed in the agro-food sector are short-term or single-season contracts" (Jang and Olson 2010, p. 252).

quality requirements.

Profits. The downstream firms' profits are given by[19]

$$\pi^{D_i}(\cdot) = R_i(X_i, q_i) - \sum_{j=a}^{A} F_{ij} \text{ with: } \begin{cases} a = 1,\ A = N_1 & \text{for } i = 1 \\ a = N_1 + 1,\ A = N & \text{for } i = 2 \end{cases}, \tag{5}$$

where $R_i(X_i, \cdot) = p_i(X_i, q_i)X_i$ denotes the revenue of retailer D_i. Our assumptions on the inverse demand guarantee that the profit $\pi^{D_i}(\cdot)$ is strictly concave in X_i.

For the upstream firm U_{ij} supplying the downstream firm D_i, the profit refers to

$$\pi^{U_{ij}}(\cdot) = F_{ij} - C(x_{ij}, q_i),\ \forall i = 1, 2,\ j = 1, ..., N. \tag{6}$$

In summary, we consider the following four-stage game. First, the two retailers D_i impose a private quality standard q_i. Given the quality choice of the retailers, the N upstream firms U_{ij} decide which downstream firm they supply and, therefore, which quality standard they comply with. This decision determines the suppliers' quality-related production costs. In the third stage, both retailers negotiate with their respective suppliers about quantity-forcing delivery contracts $T_{ij}(x_{ij}, F_{ij})$. Production takes place upon successful completion of the negotiations. Finally, the retailers sell to consumers.

3 Benchmark

We start our analysis with a benchmark case where the upstream firms have no outside option when negotiations with their selected downstream firm fail. This approach enables us to investigate the retailers' quality decision as if any retailer and its suppliers are vertically integrated, neglecting any strategic considerations in the supplier-retailer relationship. Since our solution concept is subgame perfection, the game is solved by backward induction.

Downstream Markets. In the last stage of the game, each retailer maximizes its profit given the delivery contracts negotiated before in the form of quantity-forcing tariffs $T_{ij}(x_{ij}, F_{ij})$.

Negotiations. To solve for the negotiation outcome in the intermediate goods market, we first determine the disagreement payoffs of the negotiating parties. When the retailers fail to achieve an agreement with one of their suppliers, they cannot replace this supplier but they are left to sell the quantities obtained from the remaining suppliers. In turn, we assume in this benchmark case that the upstream suppliers have no trading alternatives

[19] In order to simplify the notation, we omit the arguments of the functions where this does not lead to any confusion.

in the case of disagreement with their selected retailer. Their outside option is, therefore, normalized to zero. Applying the Nash bargaining solution,[20] the equilibrium bargaining outcome can be characterized by the solution of

$$\max_{x_{ij},F_{ij}} \left[\pi^{D_i}(X_i, F_{ij}, \cdot) - \pi^{D_i}(X_i - x_{ij}, \cdot)\right] \pi^{U_{ij}}(x_{ij}, F_{ij}, \cdot), \tag{7}$$

where $\pi^{D_i}(X_i - x_{ij}, \cdot)$ refers to the profit of retailer D_i in the case of disagreement with supplier U_{ij}.

The symmetric equilibrium quantity $x_{ij}^B = x_i^B$ that retailer D_i negotiates with each supplier U_{ij} is, thus, implicitly given by the solution of

$$\frac{\partial p_i(X_i, \cdot)}{\partial X_i} X_i + p_i(X_i, \cdot) - \frac{\partial C(x_{ij}, q_i)}{\partial x_{ij}} = 0. \tag{8}$$

Note that the equilibrium quantity maximizes the joint profit of the respective retailer-supplier pair. Note further that the retailers sell exactly what they get from the upstream suppliers, i.e. $X_i^B = N_i x_i^B$. That is, the negotiations impose a binding constraint on the retailers' quantity decision.

The fixed fees are set as to share the joint profit, whereby each party gets its disagreement payoff plus half of the incremental gains from trade. More precisely, the retailer and a given supplier equally share the marginal contribution of the supplier's delivery to the overall revenue of the retailer, i.e. $R_i(X_i^B, \cdot) - R_i(X_i^B - x_i^B, \cdot)$, as well as the supplier's total costs of $C(x_i^B, q_i)$. Hence, the symmetric equilibrium fixed fees are given by

$$\begin{aligned} F_{ij}^B(\cdot) &= F_i^B(\cdot) = \frac{1}{2}\left[\Delta R_i(X_i^B, \cdot) + C(x_i^B, q_i)\right] \\ \text{with} &: \Delta R_i(X_i^B, \cdot) = R_i(X_i^B, \cdot) - R_i(X_i^B - x_i^B, \cdot). \end{aligned} \tag{9}$$

We find that $x_i^B(q_i, N_i)$ is decreasing in the number of suppliers delivering to D_i. Thus, the more upstream firms supply the same retailer, the lower the quantity delivered by each supplier. As a consequence, the suppliers have lower production costs at the margin, resulting in a higher joint profit for each retailer-supplier pair.

Lemma 1 *For given N_i and q_i, the symmetric equilibrium delivery tariff is given by $T_i(x_i^B, F_i^B)$ where $x_i^B(q_i, N_i)$ maximizes the joint profit of each retailer-supplier pair and the fixed fee $F_i^B(q_i, N_i)$ shares the joint profit. Comparative statics reveal that $x_i^B(q_i, N_i)$ is decreasing in N_i and increasing in N_k, $i, k = 1, 2$, $i \neq k$.*

[20] This cooperative approach can be interpreted in terms of a non-cooperative bargaining like the alternating-offers bargaining proposed by Rubinstein (1982). If the time interval between offers becomes relatively small, the solution of the dynamic non-cooperative process converges to the symmetric Nash bargaining solution (Binmore et al. 1986).

Proof. See Appendix. ■

Delivery. When deciding which downstream firm to deliver to, the upstream firms balance their profits in either case. The more upstream firms decide to deliver to the same retailer, the lower their marginal contribution to the joint profit. Accordingly, we have

Lemma 2 *The difference in the upstream firms' profits, $\Delta\pi^U = \pi^{U_{ij}}(x_i^B, F_i^B, N_i, q_i, q_k) - \pi^{U_{kj}}(x_k^B, F_k^B, N_k, q_k, q_i)$, $i,k = 1,2$, $i \neq k$, is monotonically decreasing in N_i.*

Proof. See Appendix. ■

Numerically, we can show that $\pi^{U_{ij}}(x_i^B, F_i^B, 1, \cdot) > \pi^{U_{kj}}(x_k^B, F_k^B, N-1, \cdot)$, $i,k = 1,2$, $i \neq k$. Therefore, the equilibrium number of firms selling to D_i, i.e. $N_i^B(q_i, q_k)$, is implicitly given by

$$\pi^{U_{ij}}(x_i^B, F_i^B, N_i^B, \cdot) \equiv \pi^{U_{kj}}(x_k^B, F_k^B, N_k^B, \cdot), \;\; i,k = 1,2, \;\; i \neq k. \tag{10}$$

Correspondingly, $N_k^B(q_i, q_k)$ upstream firms decide to supply D_k. This number is calculated via the relationship $N_k = N - N_i$.

Quality. In the first stage of the game, both retailers decide about the quality standards they implement. Using our previous results, the equilibrium quality requirements of the retailers are given by the maximization of the retailers' reduced-profit functions, i.e.

$$q_i^B := \arg\max R_i\left(X_i^B, q_i, q_k\right) - N_i^B(q_i, q_k) F_i^B\left(q_i, q_k\right). \tag{11}$$

Applying (4), numerical solutions give us

Proposition 1 *There exists a unique symmetric equilibrium in the quality requirements of the retailers, i.e. $q_1^B = q_2^B = q^B$, if the upstream firms have no outside option in the case of negotiation breakdown. Consequently, the suppliers split up equally between both retailers, i.e. $N_1^B(q_1, q_2) = N_2^B(q_1, q_2) = N/2$.*

Proof. See Appendix. ■

4 Equilibrium Analysis

Next, taking into account suppliers' outside options, the negotiations in the intermediate goods market proceed as follows. Each supplier U_{ij} negotiates with its selected retailer D_i about a quantity-forcing contract. In the case of disagreement with D_i, supplier U_{ij} can switch to the other retailer D_k when complying with the respective quality requirements q_k. Thus, any supplier can switch its delivery from one to the other retailer whenever both retailers implement the same quality requirements. If the retailers impose different quality standards, only suppliers producing according to the higher quality standard—and, therefore, initially negotiating with the high-quality retailer—can opt to deliver to the retailer with the less demanding quality requirements. Hence, supplier U_{ij} can only switch to D_k if $q_k \leq q_i$, while it has no outside option in the case of $q_k > q_i$. Since suppliers cannot adjust their product's quality in the short-term, the switching suppliers still incur the variable costs associated with the higher quality requirements. However, they are able to adjust the quantity to be produced as production starts after successful completion of the negotiations.

Using subgame perfection as our equilibrium concept, we first analyze the negotiation outcome when supplier U_{ij} switches from D_i to D_k. Subsequently, we turn to the negotiations between the supplier and its initially chosen retailer D_i.[21]

Specification of the Disagreement Payoffs. Assuming $q_i \geq q_k$, we denote an upstream firm that switches from D_i to D_k by $\widetilde{U}_{kj}$. The switching supplier $\widetilde{U}_{kj}$ negotiates with D_k about a delivery tariff in the form of $\widetilde{T}_{kj}(\widetilde{x}_{kj}, \widetilde{F}_{kj})$, taking the contracts between D_k and all its initial suppliers U_{kj} as given. As the switching upstream firm can adjust its quantity but not its quality-related production costs, the switching supplier's production costs amount to $C(\widetilde{x}_{kj}, q_i)$. Thus, the profit of the switching supplier $\widetilde{U}_{kj}$ refers to

$$\widetilde{\pi}^{\widetilde{U}_{kj}}(\cdot) = \widetilde{F}_{kj} - C\left(\widetilde{x}_{kj}, q_i\right). \tag{12}$$

The profit of the downstream retailer D_k is, then, given by

$$\widetilde{\pi}^{D_k}(\cdot) = R_k(X_k + \widetilde{x}_{kj}, \cdot) - \sum_{l=a}^{A} F_{kl} - \widetilde{F}_{kj} \text{ with:} \begin{cases} a = 1,\ A = N_1 & \text{for } k = 1 \\ a = N_1 + 1,\ A = N & \text{for } k = 2 \end{cases}. \tag{13}$$

Note that the switching upstream firm $\widetilde{U}_{kj}$ has no further outside option when it fails to achieve an agreement with D_k. In turn, D_k still sells the quantities of those suppliers it has already made an agreement with, i.e. suppliers U_{kj}. The disagreement payoff of retailer D_k is, thus, given by

$$\pi^{D_k}(\cdot) = R_k(X_k, \cdot) - \sum_{l=a}^{A} F_{kl} \text{ with:} \begin{cases} a = 1,\ A = N_1 & \text{for } k = 1 \\ a = N_1 + 1,\ A = N & \text{for } k = 2 \end{cases}. \tag{14}$$

Using (12), (13) and (14), the equilibrium bargaining outcome between D_k and the switch-

[21] As in the benchmark case, the quantity choice of the downstream retailers is constrained by the negotiation outcome with the upstream suppliers. Again, this constraint is always binding.

ing firm $\widetilde{U}_{kj}$ can be characterized by the solution of

$$\max_{\widetilde{x}_{kj},\widetilde{F}_{kj}} \left[\widetilde{\pi}^{D_k}(\cdot) - \pi^{D_k}(\cdot)\right] \widetilde{\pi}^{\widetilde{U}_{kj}}(\cdot). \tag{15}$$

Hence, the symmetric equilibrium quantity $\widetilde{x}^*_{kj} = \widetilde{x}^*_k$ of the switching supplier is implicitly determined by the solution of

$$\frac{\partial p_k(X_k + \widetilde{x}_{kj}, \cdot)}{\partial \widetilde{x}_{kj}}(X_k + \widetilde{x}_{kj}) + p_k(X_k + \widetilde{x}_{kj}, \cdot) - \frac{\partial C(\widetilde{x}_{kj}, q_i)}{\partial \widetilde{x}_{kj}} = 0. \tag{16}$$

Accordingly, $\widetilde{x}^*_k$ maximizes the joint profit of retailer D_k and the switching supplier. The symmetric equilibrium fixed fee is given by

$$\widetilde{F}^*_{kj}(\cdot) = \widetilde{F}^*_k(\cdot) = \frac{1}{2}\left[R_k(X_k + \widetilde{x}^*_k, \cdot) - R_k(X_k, \cdot) + C(\widetilde{x}^*_k, q_i)\right]. \tag{17}$$

That is, D_k and $\widetilde{U}_{kj}$ share equally the marginal contribution of the supplier's delivery to the overall revenue of the retailer, i.e. $R_k(X_k+\widetilde{x}^*_k, \cdot)-R_k(X_k, \cdot)$, as well as the supplier's total costs of $C(\widetilde{x}^*_k, q_i)$.

Lemma 3 *For given N_i, $q_i \geq q_k$ and $T_{ij}(x_{ij}, F_{ij})$, the symmetric equilibrium delivery contract $\widetilde{T}_k(\widetilde{x}^*_k, \widetilde{F}^*_k)$ is such that $\widetilde{x}^*_k$ maximizes the joint profit of each retailer-supplier pair $D_k - \widetilde{U}_{kj}$ and the fixed fee shares the joint profit.*

Proof. See Appendix. ■

Negotiations. We turn now to the negotiations between the upstream firm U_{ij} and its initially selected retailer D_i. If the retailer does not reach an agreement with one of its suppliers, it can still sell the quantities delivered by the remaining suppliers. Thus, the retailer's disagreement payoff is given by

$$\widehat{\pi}^{D_i}(\cdot) = R_i(X_i - x_{ij}, \cdot) - \sum_{l=a}^{A-1} F_{il} \text{ with:} \begin{cases} a = 1, \; A = N_1 & \text{for } i = 1 \\ a = N_1 + 1, \; A = N & \text{for } i = 2 \end{cases}. \tag{18}$$

Referring to Lemma 3, we specify the disagreement payoff of the upstream firm U_{ij} as

$$\widetilde{\pi}^{\widetilde{U}_{kj}*}(\cdot) = \begin{cases} \widetilde{F}^*_k(\cdot) - C(\widetilde{x}^*_k, q_i) & \text{if } q_i \geq q_k \\ 0 & \text{if } q_i < q_k \end{cases}. \tag{19}$$

Using (18) together with (5),(6) and (19), the equilibrium bargaining outcome between D_i and U_{ij} can be characterized by the solution of

$$\max_{x_{ij},F_{ij}} \left[\pi^{D_i}(\cdot) - \widehat{\pi}^{D_i}(\cdot)\right] \left[\pi^{U_{ij}}(\cdot) - \widetilde{\pi}^{\widetilde{U}_{kj}*}(\cdot)\right]. \tag{20}$$

Analoguously to x_i^B defined in (8), the symmetric equilibrium quantity $x_{ij}^* = x_i^*$ each supplier U_{ij} delivers to D_i is implicitly given by the solution of

$$\frac{\partial p_i(X_i,\cdot)}{\partial X_i}X_i^* + p_i(X_i,\cdot) - \frac{\partial C(x_{ij},q_i)}{\partial x_{ij}} = 0. \tag{21}$$

The symmetric equilibrium fixed fees $F_{ij}^* = F_i^*$ sharing the joint profits are given by

$$F_{ij}^*(\cdot) = F_i^*(\cdot) = \begin{cases} \frac{1}{2}\left[\Delta R_i(X_i^*,\cdot) + C(x_i^*,q_i) + \widetilde{F}_k^* - C(\widetilde{x}_k^*,q_i)\right] & \text{if } q_i \geq q_k \\ \frac{1}{2}\left[\Delta R_i(X_i^*,\cdot) + C(x_i^*,q_i)\right] & \text{if } q_i < q_k \end{cases}, \tag{22}$$

where $\widetilde{F}_k^* - C(\widetilde{x}_k^*, q_i)$ refers to the value of the supplier's outside option as denoted by (19). Note that the suppliers delivering to D_i have an outside option in the case of negotiation breakdown if $q_i \geq q_k$, while they do not if $q_i < q_k$. This implies that the suppliers get a larger share of the joint profit if they deliver to the high-quality retailer than if they supply the low-quality retailer. In other words, the high-quality retailer has to pay a higher fixed fee to its suppliers than the low-quality retailer.

Lemma 4 *For given N_i and q_i, there exists a symmetric equilibrium delivery contract $T_i(x_i^*, F_i^*)$ where $x_i^*(q_i, N_i)$ maximizes the joint profit of the retailer-supplier pair and the fixed fee $F_i^*(q_i, N_i)$ shares the joint profit. Furthermore, $x_i^*(q_i, N_i)$ is decreasing in N_i and increasing in N_k, $i, k = 1, 2$, $k \neq i$.*

Proof. See Appendix. ■

Using our previous results and taking into account the discontinuity in the fixed fees (see 22), the retailers' reduced-profit functions are given by

$$\pi^{D_i*} = \begin{cases} R_i(X_i^*,\cdot) - \frac{1}{2}\left[\Delta R_i(X_i^*,\cdot) + C(x_i^*,q_i) + \widetilde{F}_k^* - C(\widetilde{x}_k^*,q_i)\right] & \text{if } q_i \geq q_k \\ R_i(X_i^*,\cdot) - \frac{1}{2}\left[\Delta R_i(X_i^*,\cdot) + C(x_i^*,q_i)\right] & \text{if } q_i < q_k \end{cases}. \tag{23}$$

Delivery Choice of Upstream Firms. Taking the quality choice of the downstream firms as given, the upstream firms decide which of the two retailers to supply. If the retailers' quality requirements differ, suppliers have an outside option and, thus, a better bargaining position when opting for the high-quality retailer. Thus, adherence to the higher quality standard is at first more attractive. However, the more upstream firms supply the same retailer, the lower their marginal contribution to the retailer's profit. That is, the quantity they deliver to the retailer is decreasing as the number of other suppliers delivering to the same retailer increases (see Lemma 4). Accordingly, we have

Lemma 5 *The difference in the upstream firms' profits, $\Delta\pi^U = \pi^{U_{ij}}(x_i^*, F_i^*, N_i, q_i, q_k) - \pi^{U_{kj}}(x_k^*, F_k^*, N_k, q_k, q_i)$, $i, k = 1, 2$, $i \neq k$, is monotonically decreasing in N_i.*

Proof. See Appendix. ■

In equilibrium, the upstream firms are indifferent as to which retailer they supply. Numerical analysis shows that $\pi^{U_{ij}}(x_i^*, F_i^*, 1, \cdot) > \pi^{U_{kj}}(x_k^*, F_k^*, N-1, \cdot)$. Therefore, the equilibrium number of suppliers selling to D_i, i.e. $N_i^*(q_i, q_k)$, is implicitly given by

$$\pi^{U_{ij}}(x_i^*, F_i^*, N_i^*, q_i, q_k) \equiv \pi^{U_{kj}}(x_k^*, F_k^*, N_k^*, q_k, q_i), \; i, k = 1, 2, \; i \neq k. \tag{24}$$

The relation $N_k = N - N_i$ gives the corresponding equilibrium number of upstream firms delivering to D_k, i.e. $N_k^*(q_i, q_k)$.

Private Quality Standards. The equilibrium quality requirements of the retailers are given by the maximization of the retailers' reduced-profit functions, i.e.

$$q_i^* := \arg\max R_i(X_i^*, q_i, q_k) - N_i^*(q_i, q_k) F_i^*(q_i, q_k). \tag{25}$$

In contrast to the benchmark case, there exists no symmetric equilibrium in qualities if the suppliers have an outside option in the case of negotiation breakdown. Instead, we find that there exist two asymmetric equilibria in the retailers' quality choice. Taking a relatively high quality standard q_i^* as given, the best response of retailer D_k is to considerably undercut the quality requirements of D_i (see Figure 1a).[22] If q_k drops just below q_i^*, i.e. $q_k = q_i^* - \varepsilon$, the suppliers U_{kj} complying with q_k lose their outside option in the negotiations with retailer D_k. This makes delivery to the now low-quality retailer less attractive than supplying the high-quality retailer. Accordingly, fewer suppliers decide to deliver to the low-quality retailer D_k. From Lemma 4 we know that the quantity to be delivered by each supplier, i.e. x_k^*, is increasing when the number of upstream firms N_k supplying the same retailer is decreasing. Since marginal production costs are increasing in quantity and quality, the decreasing number of suppliers at the low-quality retailer results in a disproportionately strong increase in the production costs. Retailer D_k, therefore, has an incentive to considerably undercut q_i^*. This is driven by two effects. First, lower quality requirements result in lower production costs, which may—at least partly—compensate for the cost increase due to the higher quantity produced by each supplier. Second, the lower the q_k relative to q_i^*, the lower the outside options of suppliers U_{ij} when delivering to the high-quality retailer D_i. The reason is that the suppliers, when switching to the low-quality retailer, still incur production costs associated with the high quality without getting rewarded for overcomplying with the low quality standard. Accordingly, a larger spread in quality requirements makes delivery to the high-quality retailer less attractive. Note that the retailer has no incentive to decrease its quality requirements unlimitedly

[22] Note that retailer D_k has no incentive to leapfrog the other retailer's quality requirements, as long as the production costs are sufficiently convex in quality and quantity.

since the reduced quality implies lower prices in the final consumer market and, thus, decreases the retailer's revenue.

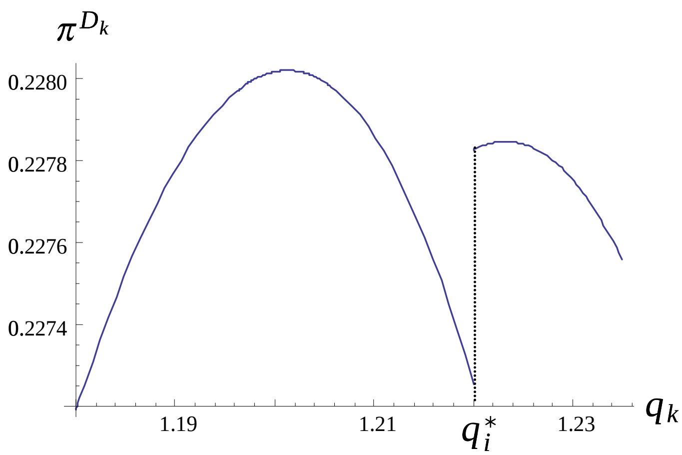

Figure 1a: π^{D_k} in q_k for q_i^*

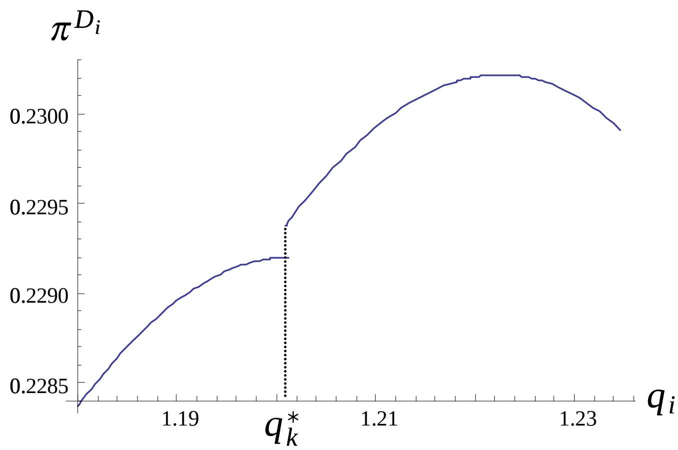

Figure 1b: π^{D_i} in q_i for q_k^*

Considering now a relatively low value of q_k^*, the best response of retailer D_i is to raise its quality requirements above q_k^* (see Figure 1b).[23] Similarly to the case described above, already a slight increase in q_i improves both retailers' bargaining position. The outside option of the suppliers delivering to the high-quality retailer D_i becomes less valuable, while the low-quality retailer's suppliers lose their outside option completely. As the latter effect dominates the former, delivery to D_i becomes more profitable for a supplier than

[23] Analoguously to the above constellation, retailer D_i has no incentive to undercut the other retailer's quality requirements.

delivery to D_k. This results in a larger number of suppliers delivering to D_i. Accordingly, the quantity to be delivered by each single upstream firm U_{ij} gets reduced leading to lower production costs (see Lemma 4). The retailer D_i is, thus, able to considerably increase q_i in order to further improve its bargaining position. However, at some point, the rise in the quality-related production costs will dominate the favorable quantity effect. This will put limits to the rise in q_i.

As the revenue effect dominates the effect on production costs, the joint profit the low-quality retailer earns with any of its suppliers is smaller than the respective joint profit obtained by the high-quality retailer. Referring to the above-described outside-option effect, we can state that the low-quality retailer gets a larger share of a smaller pie, while the high-quality retailer gets a smaller share of a larger pie. Furthermore, our results reveal that the high-quality retailer attracts more suppliers, implying lower production costs per supplier and, thus, resulting in a larger overall quantity offered in the final consumer market.

5 Extensions and Discussion

In the following, we relax the assumption of two local retail monopolies and allow the retailers to compete in one single market. Based on this model extension, we analyze the effect of downstream competition on retailers' quality choice, discuss the welfare implications of private standard setting and study the impact of a public MQS on the retailers' private quality requirements and on social welfare.

Introducing downstream competition, we apply the following inverse demand functions

$$p_i(\cdot) := \max\{q_i - X_i - \sigma X_k, 0\}, \ \forall i, k = 1, 2, \ i \neq k, \tag{26}$$

where $\sigma \in [0, 1)$ indicates the substitutability between the retailers' products 1 and 2.[24] That is, the closer σ approaches one, the higher the degree of substitutability between the products.

Downstream Competition. Assuming that the retailers compete in quantities and that their products constitute imperfect substitutes, the analysis still reveals asymmetric equilibria in the retailers' quality decision, i.e. $q_i^* > q_k^*$ (see Figure 2). The extent of asymmetry in the retailers' quality choice becomes more pronounced the more that the retailers compete. That is, the spread between q_i^* and q_k^* is increasing in the degree of substitutability. This is due to the fact that the intensity of downstream competition increases as product substitutability improves. In the case of local monopolies ($\sigma = 0$),

[24] The equilibrium quantities and fixed fees derived from the linear example can be found in the Appendix.

retailer D_k decreases its quality requirements in order to improve its bargaining position in the intermediate goods market. For the same reason, retailer D_i enhances its quality requirements. If the retailers operate in the same market and compete in quantities ($\sigma > 0$), there is an additional effect. By increasing its quality requirements, D_i commits itself to selling a smaller quantity to final consumers. As quantities are strategic substitutes in our setting, the best response of the competitor D_k is to increase its quantity in the final consumer market. D_k is able to do so by decreasing its quality requirements.

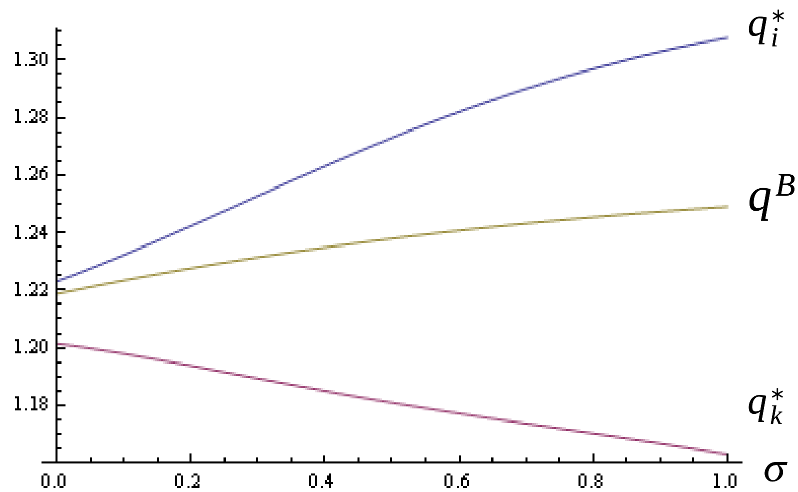

Figure 2: Equilibrium Quality Requirements q_i^*, q_k^* and q^B in σ for $N = 10$, $i, k = 1, 2$, $i \neq k$

Social Welfare. In order to evaluate the welfare effect of the retailers' private standard setting, we compare the profit-maximizing quality levels to the quality requirements obtained under welfare maximization. For this purpose, we define social welfare as the sum of consumer surplus CS and industry profit Π, whereby industry profit refers to the sum of the retailers' and the suppliers' profits, i.e. we have

$$\begin{aligned} W(\cdot) \quad = \quad & \int_0^{X_1^*(q_1,q_2)} p_1(\overline{X}_1, 0, q_1) d\overline{X}_1 + \int_0^{X_2^*(q_1,q_2)} p_2(X_1^*(\cdot), \overline{X}_2, q_2) d\overline{X}_2 \\ & -N_1^*(\cdot) C(x_1^*(\cdot), q_1) - N_2^*(\cdot) C(x_2^*(\cdot), q_2). \end{aligned} \tag{27}$$

Note that we evaluate social welfare for given negotiation outcomes and, therefore, pursue a second-best approach.[25] Hence, the socially optimal quality requirements are given by

$$q_i^W := \arg\max W(\cdot), \ \forall i = 1, 2. \tag{28}$$

If the upstream firms have an outside option, the profit-maximizing quality choice of the downstream firms will deviate from the socially optimal quality levels. Numerical analysis reveals that $q_i^* > q_i^w > q_k^w > q_k^*$ for all σ. That is, D_i exaggerates its quality requirements q_i^* by exceeding the socially optimal quality level q_i^w, while the best response of D_k leads to quality requirements q_k^* that undercut the socially optimal quality level q_k^w (see Figure 3). Thus, the strategic use of private quality requirements in vertical relations implies a welfare loss.

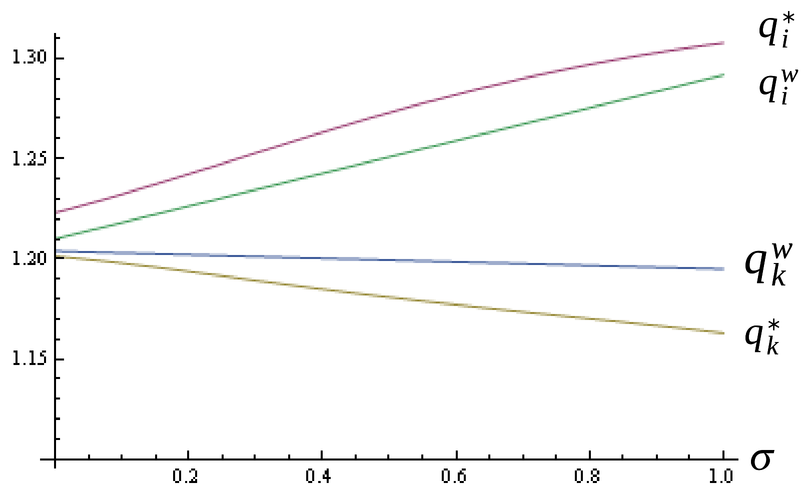

Figure 3: Quality Requirements q_i^*, q_k^* and q_i^w, q_k^w in σ for $N = 10$, $i, k = 1, 2$, $i \neq k$

In Figure 4, we decompose the difference in the welfare levels obtained under profit maximization and under welfare optimization, $\Delta W = W(q_i^*, q_k^*, \cdot) - W(q_i^w, q_k^w, \cdot)$, into the respective differences in consumer surplus, $\Delta CS = CS(q_i^*, q_k^*, \cdot) - CS(q_i^w, q_k^w, \cdot)$, and industry profits, $\Delta\Pi = \Pi(q_i^*, q_k^*, \cdot) - \Pi(q_i^w, q_k^w, \cdot)$. For relatively low σ, the welfare loss due to the retailers' profit maximization is driven entirely by a loss in consumer surplus. For high σ, the difference in industry profits also becomes negative. Both effects combined lead to a rise in the welfare loss in the degree of substitutability.

[25] In general, public authorities are not in the position to intervene into the negotiation process between the retailers and suppliers.

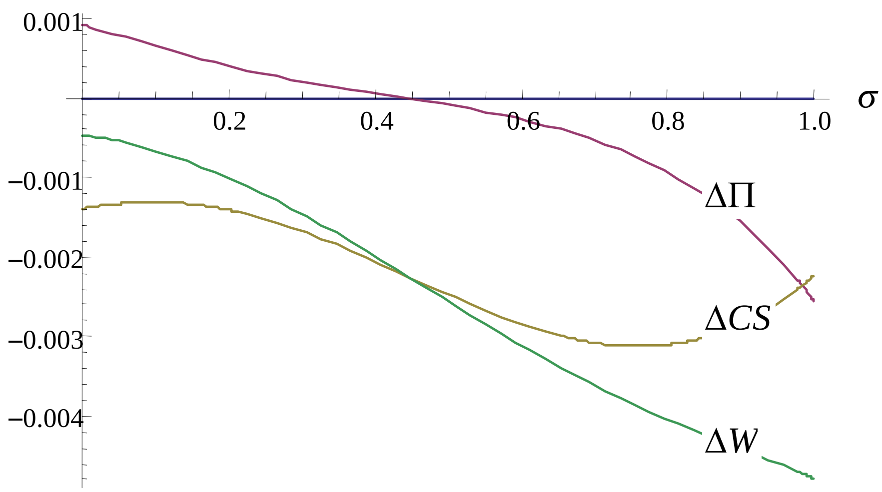

Figure 4: Welfare Decomposition in σ for $N = 10$

Minimum Quality Standard. The negative welfare effect of the retailers' quality choice can be softened by the enforcement of a binding public MQS. Under such a MQS, the possibilities of retailer D_k to decrease its quality requirements are limited, resulting in less demanding quality requirements by the other retailer D_i. The optimal level of the public MQS, $\underline{q}_k^w$, is obtained by maximizing (27) with respect to q_k, whereby the higher quality, q_i, is determined by the best response of retailer D_i denoted $r_i(q_k)$, i.e.

$$\underline{q}_k^w := \arg\max W(r_i(q_k), q_k, N_i^*(r_i(q_k), q_k)),\ \forall k = 1, 2. \tag{29}$$

Our numerical analysis shows that the implementation of a public MQS increases social welfare (see Figures 5a and 5b). The stronger the downstream competition, i.e. the higher σ, the lower the optimal public MQS, but the larger the interval in which raising the lower quality standard above its profit-maximizing level is welfare-increasing.

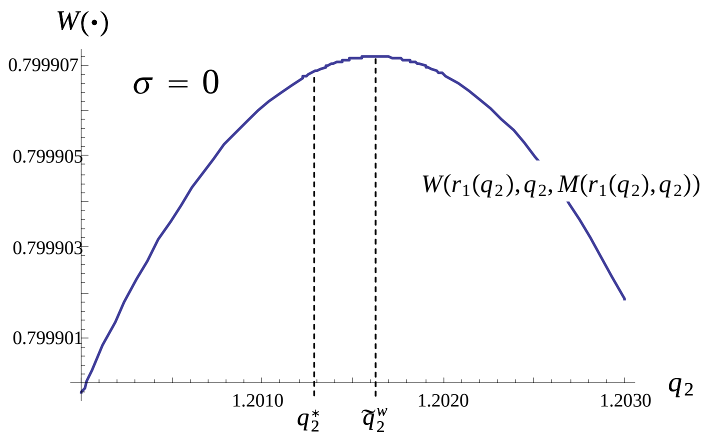

Figure 5a: Welfare Effects of Public MQS for $\sigma = 0$

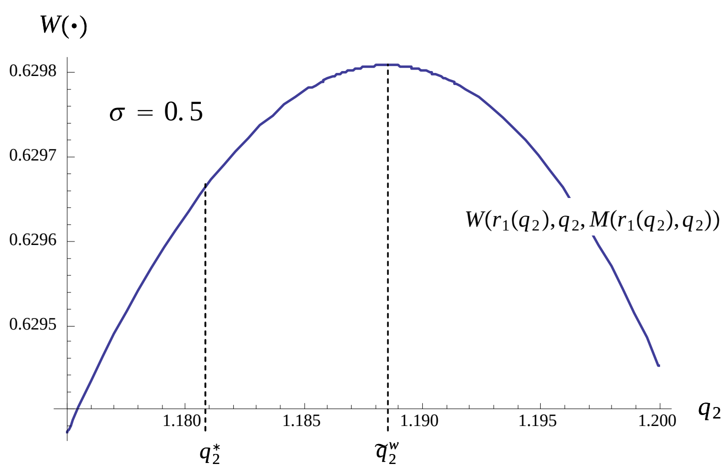

Figure 5b: Welfare Effects of Public MQS for $\sigma = 0.5$

6 Conclusion

The analysis conducted in this paper reveals that retailers use private quality standards to weaken the bargaining position of their suppliers and, thus, to improve their own bargaining power within the food supply chain. More precisely, we find that both retailers imply equal quality standards if their suppliers have no outside options in the case of negotiation breakdown. In turn, there exist two asymmetric equilibria in the downstream firms' quality choice if the suppliers are able to switch their delivery to the other retailer should negotiations fail. Accordingly, our results clearly indicate that retailers use their private quality standards for strategic purposes in the intermediate goods markets.

Furthermore, we show that the spread in the quality requirements is increasing in the degree of downstream competition. Due to higher marginal costs of production, a more demanding quality standard by one retailer induces a lower quantity sold in the final consumer market. The best response of the competing retailer is to reduce its quality requirements in order to increase its quantity in the final consumer market. This effect becomes more pronounced the less differentiated the retailers are and, thus, the more they compete.

The strategic use of private quality requirements is detrimental to social welfare. The quality standard set by the high-quality retailer exceeds the corresponding socially optimal quality level, while the quality standard of the low-quality retailer undercuts it. Public regulation, in the form of a binding MQS, can remedy this unfavorable welfare outcome as it increases the lower quality level and, thus, prevents the other retailer from exaggerating its own quality requirements.

Our results are limited to cases where suppliers are capacity constrained and where the increase in production costs for higher quality requirements is sufficiently strong. Furthermore, we assume that suppliers cannot easily change their production process to comply with different quality requirements. Accordingly, the effect we describe in this model can be observed in industries where producers face high quality-related production costs and are locked in their production process in the short-term. Examples include the production of fruits and vegetables.

References

[1] Balsevich, J., Berdegué, A., Flores, L., Mainville, D. and T. Reardon (2003), "Supermarkets and Produce Quality and Safety Standards in Latin America", *American Journal of Agricultural Economics* 85: 1147-1154.

[2] Battigalli, P., Fumagalli, C. and M. Polo (2007), "Buyer Power and Quality Improvement", *Research in Economics* 61: 45-61.

[3] Bazoche, P., Giraud-Héraud, E. and L.-G. Soler (2005), "Premium Private Labels, Supply Contracts, Market Segmentation, and Spot Prices", *Journal of Agricultural and Food Industrial Organization* 3: Article 7.

[4] Bernard, J. C. and D. J. Bernard (2009), "What Is It About Organic Milk? An Experimental Analysis", *American Journal of Agricultural Economics* 91: 826-836.

[5] Berto Villas-Boas, S. (2007), "Vertical Relationships between Manufacturers and Retailers: Inference with Limited Data", *Review of Economic Studies* 74: 625–652.

[6] Binmore et al. (1986), "The Nash Bargaining Solution in Economic Modelling", *Rand Journal of Economics* 17: 176-188.

[7] Boselie, D., Henson, S. and D. Weatherspoon (2003), "Supermarket Procurement Practices in Developing Countries: Redefining the Roles of the Public and Private Sectors", *American Journal of Agricultural Economics* 85: 1155-1161.

[8] Bonnet, C. and P. Dubois (2010), "Inference on Vertical Contracts between Manufacturers and Retailers Allowing for Nonlinear Pricing and Resale Price Maintenance", *RAND Journal of Economics* 41: 139-164.

[9] Bougherara, D. and P. Combris (2009), "Eco-Labelled Food Products: What are Consumers Paying for?", *European Review of Agricultural Economics* 36: 321-341.

[10] Brooks, K. and J. L. Lusk (2010), " Stated and Revealed Preferences for Organic and Cloned Milk: Combining Choice Experiment and Scanner Data", *American Journal of Agricultural Economics* 92: 1229-1241.

[11] Chambolle, C. and S. Berto Villas-Boas (2010), "Buyer Power through Producers' Differentiation", mimeo.

[12] Chen Z. (2004), "Monopoly and Product Diversity: The Role of Retailer Countervailing Power", mimeo, Carleton University.

[13] Codron, J.-M., Giraud-Héraud, E. and L.-G. Soler (2005), "Minimum Quality Standards, Premium Private Labels, and European Meat and Fresh Produce Retailing", *Food Policy* 30: 270-283.

[14] Crampes, C. and A. Hollander (1995), "Duopoly and Quality Standards", *European Economic Review* 39: 71-82.

[15] Dobson, P. W., Waterson, M. and S. W. Davies (2003), "The Patterns and Implications of Increasing Concentration in European Food Retailing", *Journal of Agricultural Economics* 54: 111-125.

[16] EC (2006), *Private Food Standards and Their Impacts on Developing Countries*, European Commission, DG Trade Unit G2, trade.ec.europa.eu/doclib/ html/127969.htm.

[17] Gal-Or, E. (1985), "Differentiated Industries without Entry Barriers", *Journal of Economic Theory* 37: 310-339.

[18] Gal-Or, E. (1987), "Strategic and Non-Strategic Differentiation", *Canadian Journal of Economics* 20: 340-356.

[19] Gao, Z. and T. C. Schroeder (2009), "Effects of Lavel Information on Consumer Willingness-to-Pay for Food Attributes", *American Journal of Agricultural Economics* 91: 795-809.

[20] García Martinez, M. and N. Poole (2004), "The Development of Private Fresh Produce Safety Standards: Implications for Developing Mediterranean Exporting Countries", *Food Policy* 29: 229-255.

[21] Gil, J. M., A. Gracia and M. Sánchez (2000), "Market Segmentation and Willingness to Pay for Organic Products in Spain", *International Food and Agribusiness Management Review* 3: 207-226.

[22] Giraud-Héraud, E., Rouached, L. and L.-G. Soler (2006a), "Private Labels and Public Quality Standards: How Can Consumer Trust Be Restored after the Mad Cow Crisis?", *Quantitative Marketing and Economics* 4 (1): 31-55.

[23] Giraud-Héraud, E., Hammoudi, H. and L.-G. Soler (2006b), "Food Safety, Liability and Collective Norms", Cahiers du Laboratoire d'Econométrie de l'Ecole Polytechnique, No. 2006-06.

[24] Giraud-Héraud, E., Hammoudi, H., Hoffmann, R. and L.-G. Soler (2008), "Vertical Relationships and Safety Standards in the Food Marketing Chain", Working Paper ALISS 2008-07.

[25] Hammoudi, A., Hoffmann, R. and Y. Surry (2009), "Food Safety Standards and Agri-Food Supply Chains: An Introductory Overview", *European Review of Agricultural Economics* 36 (4): 469-478.

[26] Inderst, R. and N. Mazarotto (2008), "Buyer Power in Distribution", in: Collins, W. D. (ed.) ABA Antitrust Section Handbook, Issues in Competition Law and Policy.

[27] Inderst, R. and G. Shaffer (2008), "The Role of Buyer Power in Merger Control", in: Collings, W. D. (2008) ABA Antitrust Section Handbook, Issues in Competition Law and Policy.

[28] Inderst, R. and G. Shaffer (2007), "Retail Mergers, Buyer Power, and Product Variety", *Economic Journal* 117: 45-67.

[29] Inderst, R. and C. Wey (2007), "Buyer Power and Supplier Incentives", *European Economic Review* 51: 647-667.

[30] Inderst, R. and C. Wey (2003), "Bargaining, Mergers, and Technology Choice in Bilaterally Oligopolistic Industries", *RAND Journal of Economics* 34: 1-19.

[31] Jang, J. and F. Olson (2010), "The Role of Product Differentiation for Contract Choice in the Agro-Food Sector", *European Review of Agricultural Economics* 37: 251-273.

[32] Kanter, C., Messer, K. D. and H. M. Kaiser (2009), "Does Production Labeling Stigmatize Conventional Milk?", *American Journal of Agricultural Economics* 91: 1097-1109.

[33] Katz, M. L. (1987), "The Welfare Effects of Third Degree Price Discrimination in Intermediate Goods Markets", *American Economic Review* 77: 154-167.

[34] Lutz, S., Lyon, T. P. and J. W. Maxwell (2000), "Quality Leadership when Regulatory Standards are Forthcoming", *Journal of Industrial Economics* 48: 331-348.

[35] Marcoul, P. and L. Veyssiere (2010), "A Financial Contracting Approach to the Role of Supermarkets in Farmers' Credit Access", *American Journal of Agricultural Economics* 92: 1051-1064.

[36] Marks & Spencer (2010), *How We Do Business Report 2010*, Marks and Spencer Group plc, United Kingdom.

[37] Mayen, C. D., J. V. Balagtas, and C. E. Alexander (2010), "Technology Adaption and Technical Efficiency: Organic and Conventional Dairy Farms in The United States, *American Journal of Agricultural Economics* 92: 181-195.

[38] McCluskey, J. J. and J. A. Winfree (2009), "Pre-Empting Public Regulation with Private Food Quality Standards", *European Review of Agricultural Economics* 36: 525-539.

[39] Montez, J. V. (2008), "Downstream Mergers and Producer's Capacity Choice: Why Bake a Larger Pie When Getting a Smaller Slice?", *RAND Journal of Economics* 38: 948-966.

[40] Motta, M. (1993), "Endogenous Quality Choice: Price vs. Quantity Competition", *Journal of Industrial Economics* 41: 113-131.

[41] OECD (2007), "Private Standard Schemes and Developing Country Access to Global Value Chains: Challenges and Opportunities Emerging from Four Case Studies", available at: www.olis.oecd.org/olis/2006doc.nsf/linkto/agr-ca-apm(2006)20-final.

[42] OECD (2006), "Final Report on Private Standards and the Shaping of the Agro-food System", available at: www.olis.oecd.org/olis/2006doc.nsf/43bb6130e5e86e5fc12569 fa005d004c/4e3a2945ffec37eec12571bc00590ce3/$FILE/JT03212398.PDF.

[43] PAN Europe (2008), "Supermarkets", Fact Sheet, available at: http://www.pan-europe.info/Resources/Factsheets/Supermarkets.pdf.

[44] Preidl, M. and M.-L. Rau (2006), "Obligatory and Voluntary Standards in Polish Meat Production/Processing", in: Bokusheva, R. and G. Buchenrieder (eds.), "Contributions to the 4th Young Scientists Workshop on Agricultural Development in Central and Eastern Europe", Discussion Paper No. 98, Halle: Institute for Agricultural Development in Central and Eastern Europe (IAMO).

[45] Rau, M.-L. and F. van Tongeren (2009), "Heterogeneous Firms and Homogenising Standards in Agri-Food Trade: The Polish Meat Case", *European Review of Agricultural Economics* 36 (4): 479-505.

[46] Rey, P. and T. Vergé (2008), "Economics of Vertical Restraints", in: Handbook of Antitrust Economics, Paolo Buccirossi (eds.), The MIT Press 2008: 353-390.

[47] Reyniers, D. J. and C. S. Tapiero (1995), "‘The Delivery and Control of Quality in Supplier-Producer Contracts"’, *Management Science* 41: 1581-1589.

[48] Ronnen, U. (1991), "Minimum Quality Standards, Fixed Costs, and Competition", *RAND Journal of Economics* 22: 490-504.

[49] Rubinstein, A. (1982), "Perfect Equilibrium in a Bargaining Model", *Econometrica* 50: 97-109.

[50] Sheffman, D. T. and P. T. Spiller (1992), "Buyers’ Strategies, Entry Barriers, and Competition", *Economic Inquiry* 30: 418-436.

[51] Valletti, T. M. (2000), "Minimum Quality Standards under Cournot Competiton", *Journal of Regulatory Economics* 18: 235-245.

[52] Wal-Mart (2008a), *Wal-Mart Becomes First Nationwide U.S. Grocer To Adopt Global Food Safety Initiative Standards*, accessed on 8 March 2011 via http://walmartstores.com/pressroom/news/7918.aspx.

[53] Wal-Mart (2008b), *Wal-Mart is Taking the Lead on Sustainable Packaging*, accessed on 2 March 2011 via http://walmartstores.com/pressroom/factsheets/.

[54] Wal-Mart (2011), *China Sustainability Summit: Fact Sheet*, accessed on 2 March 2011 via http://walmartstores.com/pressroom/factsheets/.

Appendix

Proof of Lemma 1. Maximizing (7) with respect to x_{ij} and F_{ij}, we obtain the following first-order conditions

$$\frac{\partial \pi^{D_i}(X_i, \cdot)}{\partial x_{ij}} \pi^{U_{ij}}(x_{ij}, \cdot) + \frac{\partial \pi^{U_{ij}}(x_{ij}, \cdot)}{\partial x_{ij}} \left[\pi^{D_i}(X_i, \cdot) - \pi^{D_i}(X_i - x_{ij}, \cdot)\right] = 0 \tag{30}$$

and

$$-\pi^{U_{ij}}(x_{ij}, F_{ij}) + \pi^{D_i}(X_i, F_{ij}, \cdot) - \pi^{D_i}(X_i - x_{ij}, \cdot) = 0. \tag{31}$$

A rearrangement of (31) yields

$$\frac{\pi^{D_i}(X_i, \cdot) - \pi^{D_i}(X_i - x_{ij}, \cdot)}{\pi^{U_{ij}}(x_{ij}, \cdot)} = 1. \tag{32}$$

Using (32) and rearranging (30), we further obtain

$$\frac{\partial \pi^{D_i}(X_i, \cdot)}{\partial x_{ij}} = -\frac{\partial \pi^{U_{ij}}(x_{ij,} \cdot)}{\partial x_{ij}}. \tag{33}$$

With $\partial X_i / \partial x_{ij} = 1$, it follows that the optimal quantity, x_{ij}^B, is implicitly given by the solution of

$$\frac{\partial p_i(X_i, \cdot)}{\partial X_i} X_i + p_i(X_i, \cdot) - \frac{\partial C(x_{ij}, q_i)}{\partial x_{ij}} = 0. \tag{34}$$

Solving (34) and applying symmetry, we get

$$\begin{aligned} x_{ij}^B &= x_i^B = \frac{2c_k q_i + N_k 2q_i}{4\left(c_i + N_i\right)\left(c_k + N_k\right)} \\ \text{with:} & \quad c_l = q_l^2/[2\left(2 - q_l^2\right)],\ \forall l = i, k. \end{aligned} \tag{35}$$

Solving (32) for F_{ij}^B and using symmetry, we obtain

$$F_{ij}^B(\cdot) = F_i^B(\cdot) = \frac{1}{2}\left[R_i(X_i^B, \cdot) - R_i(X_i^B - x_i^B, \cdot) + C(x_i^B, q_i)\right], \tag{36}$$

which simplifies to

$$\begin{aligned} F_i^B(\cdot) &= \frac{1}{2}\left[x_i^B\left(q_i + (1 - 2N_i)\, x_i^B\right) + c_i\left(x_i^B\right)^2\right] \\ \text{with} &: \quad c_i = q_i^2/[2\left(2 - q_i^2\right)]. \end{aligned} \tag{37}$$

Inspection of (35) shows that $\partial x_i^B / \partial N_i < 0$ and $\partial x_i^B / \partial N_k > 0$.

Proof of Lemma 2. We first show that

$$\frac{\partial \Delta\pi^{U}(\cdot)}{\partial N_i} = \frac{\partial\left[\pi^{U_{ij}}(x_i^B, F_i^B, \cdot) - \pi^{U_{kj}}(x_k^B, F_k^B, \cdot)\right]}{\partial N_i} < 0. \tag{38}$$

Using $X_i^B = N_i^B x_i^B$, $i = 1, 2$, applying the envelope theorem as well as $p_i(X_i^B, \cdot) - p_i(X_i^B - x_i^B, \cdot) = \left(\partial p_i\left(X_i^B, \cdot\right)/\partial X_i\right) x_i^B$, $i = 1, 2$, we get

$$\begin{aligned} \frac{\partial \Delta\pi^{U}(\cdot)}{\partial N_i} &= \frac{\partial \pi^{U_{ij}}(x_i^B, F_i^B, \cdot)}{\partial N_i} - \frac{\partial \pi^{U_{kj}}(x_k^B, F_k^B, \cdot)}{\partial N_i} < 0 \\ \text{with} &: \frac{\partial \pi^{U_{ij}}(x_i^B, F_i^B, \cdot)}{\partial N_i} = \frac{\partial p_i\left(X_i^B, \cdot\right)}{\partial X_i} x_i^B \left(x_i^B + (N_i^B - 1)\frac{\partial x_i^B}{\partial N_i}\right) < 0 \\ \text{and} &: \frac{\partial \pi^{U_{kj}}(x_k^B, F_k^B, \cdot)}{\partial N_i} = \frac{\partial p_k\left(X_k^B, \cdot\right)}{\partial X_k} x_k^B \left(-x_k^B + (N_k^B - 1)\frac{\partial x_k^B}{\partial N_i}\right) > 0 \end{aligned} \tag{39}$$

as it holds that $\partial X_i^B(\cdot)/\partial N_i = x_i^B + N_i^B \partial x_i^B/\partial N_i > 0$ as well as $\partial X_k^B(\cdot)/\partial N_i = -x_k^B + N_k^B \partial x_k^B/\partial N_i < 0$. Note also that $x_i^B + N_i^B \partial x_i^B/\partial N_i < x_i^B + \left(N_i^B - 1\right)\partial x_i^B/\partial N_i$ and $-x_k^B + N_k^B \partial x_k^B/\partial N_i > -x_k^B + \left(N_k^B - 1\right)\partial x_k^B/\partial N_i$.

Proof of Proposition 1. To prove that there exists a unique symmetric equilibrium in qualities, we show numerically that

$$\left|\frac{dq_i}{dq_k}\right| = \left|\frac{\partial^2 \pi^{D_i}}{\partial q_i \partial q_k} / \frac{\partial^2 \pi^{D_i}}{\partial q_i^2}\right| < 1. \tag{40}$$

Proof of Lemma 3. Maximizing (15) with respect to $\widetilde{x}_{kj}$ and $\widetilde{F}_{kj}$, we get

$$\left[\widetilde{\pi}^{D_k}(X_k + \widetilde{x}_{kj}, \cdot) - \pi^{D_k}(X_k, \cdot)\right] \frac{\partial \widetilde{\pi}^{\widetilde{U}_{kj}}(\cdot)}{\partial \widetilde{x}_{kj}} + \widetilde{\pi}^{\widetilde{U}_{kj}}(\widetilde{x}_{kj}, \cdot) \frac{\partial\left(\widetilde{\pi}^{D_k}(\cdot) - \pi^{D_k}(\cdot)\right)}{\partial \widetilde{x}_{kj}} = 0 \tag{41}$$

and

$$\widetilde{\pi}^{D_k}(\cdot) - \pi^{D_k}(\cdot) - \widetilde{\pi}^{\widetilde{U}_{kj}}(\cdot) = 0. \tag{42}$$

A rearrangement of (42) yields

$$\frac{\widetilde{\pi}^{D_k}(\cdot) - \pi^{D_k}(\cdot)}{\widetilde{\pi}^{\widetilde{U}_{kj}}(\cdot)} = 1. \tag{43}$$

Using (43) and rearranging (41), we further obtain

$$\frac{\partial \widetilde{\pi}^{D_k}}{\partial \widetilde{x}_{kj}} = -\frac{\partial \widetilde{\pi}^{\widetilde{U}_{kj}}}{\partial \widetilde{x}_{kj}}. \tag{44}$$

It follows that the optimal quantity $\widetilde{x}_{kj}^*$ is implicitly given by the solution of

$$\frac{\partial p_k(X_k + \widetilde{x}_{kj}, \cdot)}{\partial \widetilde{x}_{kj}}(X_k + \widetilde{x}_{kj}) + p_k(X_k + \widetilde{x}_{kj}, \cdot) - \frac{\partial C(\widetilde{x}_{kj}, q_i)}{\partial \widetilde{x}_{kj}} = 0. \tag{45}$$

Applying symmetry, we get

$$\begin{aligned} \widetilde{x}_{kj}^* &= \widetilde{x}_k^* = \frac{4c_k\left(c_i + N_i\right)q_k}{2\left(1 + c_i\right)\left[4\left(c_i + N_i\right)\left(c_k + N_k\right)\right]} \\ \text{with} &: c_l = q_l^2/[2\left(2 - q_l^2\right)],\ \forall l = i, k. \end{aligned} \tag{46}$$

Solving (43) for $\widetilde{F}_{kj}^*$ and using symmetry, we get

$$\widetilde{F}_{kj}^*\left(\cdot\right) = \widetilde{F}_k^*\left(\cdot\right) = \frac{1}{2}\left[p_k(X_k + \widetilde{x}_k^*, \cdot)(X_k + \widetilde{x}_k^*) - p_k(X_k, \cdot)X_k + C(\widetilde{x}_k^*, q_i)\right], \tag{47}$$

which simplifies to

$$\begin{aligned} \widetilde{F}_k^*\left(\cdot\right) &= \frac{1}{2}\left[\widetilde{x}_k^*\left(q_k - \widetilde{x}_k^* - 2N_k x_k^*\right) + c_i \widetilde{x}_k^{*2}\right] \\ \text{with} &: c_i = q_i^2/[2\left(2 - q_i^2\right)]. \end{aligned} \tag{48}$$

Proof of Lemma 4. The proof of Lemma 4 is analoguous to the proof of Lemma 1. In particular, we find $\partial x_i^*/\partial N_i < 0$ and $\partial x_k^*/\partial N_i > 0$. The corresponding equilibrium values for the quantities and fixed fees based on the linear example can be found at the end of the Appendix, setting $\sigma = 0$.

Proof of Lemma 5. Using $X_i^* = N_i^* x_i^*$, $i = 1, 2$, applying the envelope theorem, and exploiting the relations $p_i\left(X_i^*, \cdot\right) - p_i\left(X_i^* - x_i^*, \cdot\right) = \left(\partial p_i\left(X_i^*, \cdot\right)/\partial X_i\right) x_i^*$ and $p_k(X_k^* + \widetilde{x}_k^*, \cdot) - p_k(X_k^*, \cdot) = \left(\partial p_k\left(X_k^*, \cdot\right)/\partial X_k\right)\widetilde{x}_k^*$, we have

$$\frac{\partial \Delta\pi^U\left(\cdot\right)}{\partial N_i} = \frac{\partial \pi^{U_{ij}}(x_i^*, F_i^*, \cdot)}{\partial N_1} - \frac{\partial \pi^{U_{kj}}(x_k^*, F_k^*, \cdot)}{\partial N_i} < 0 \tag{49}$$

since it holds for $q_i > q_k$ that

$$\begin{aligned} \frac{\partial \Delta\pi^U\left(\cdot\right)}{\partial N_i} = & \frac{\partial p_i\left(X_i^*, \cdot\right)}{\partial X_i} x_i^* \left(x_i^* + \left(N_i^* - 1\right)\frac{\partial x_i^*}{\partial N_i}\right) \\ & - \frac{1}{2}\frac{\partial p_k\left(X_k^*, \cdot\right)}{\partial X_k}\left(2x_k^* - \widetilde{x}_k^*\right)\left(-x_k^* + \left(N_k^* - 1\right)\frac{\partial x_k^*}{\partial N_i}\right) \\ & + \frac{1}{2}\frac{\partial p_k\left(X_k^*, \cdot\right)}{\partial X_k}\widetilde{x}_k^* \frac{\partial x_k^*}{\partial N_i} \end{aligned} \tag{50}$$

and for $q_i = q_k$ that

$$\begin{aligned}\frac{\partial \Delta\pi^U(\cdot)}{\partial N_i} &= \frac{1}{2}\frac{\partial p_i(X_i^*,\cdot)}{\partial X_i}(2x_i^* - \widetilde{x}_i^*)\left(x_i^* + (N_i^*-1)\frac{\partial x_i^*}{\partial N_i}\right) \\ &\quad -\frac{1}{2}\frac{\partial p_k(X_k^*,\cdot)}{\partial X_k}(2x_k^* - \widetilde{x}_k^*)\left(-x_k^* + (N_k^*-1)\frac{\partial x_k^*}{\partial N_i}\right) \\ &\quad +\frac{1}{2}\frac{\partial p_k(X_k^*,\cdot)}{\partial X_k}\widetilde{x}_k^*\frac{\partial x_k^*}{\partial N_i} - \frac{\partial p_i(X_i^*,\cdot)}{\partial X_i}x_i^*\frac{\partial x_i^*}{\partial N_i}.\end{aligned} \tag{51}$$

We have $\partial\Delta\pi^U(\cdot)/\partial N_i < 0$ as long as $2x_k^* - \widetilde{x}_k^* > 0$ and $2x_i^* - \widetilde{x}_i^* > 0$ since $\partial X_i^*/\partial N_i = x_i^* + N_i^*\partial x_i^*/\partial N_i > 0$ and $\partial X_k^*/\partial N_i = -x_k^* + N_k^*\partial x_k^*/\partial N_i < 0$.

Numerical Results under Downstream Competition. Based on equations (4) and (26), the equilibrium fixed fees $F_i^*(\cdot)$ are given by

$$F_i^*(\cdot) = \begin{cases} \frac{1}{2}\left[\Delta R_i(X_i^*,\cdot) + c_i x_i^{*2} + \widetilde{F}_k^*(\cdot) - c_i\widetilde{x}_k^{*2}\right] & \text{if } q_i \geq q_k \\ \frac{1}{2}\left[\Delta R_i(X_i^*,\cdot) + c_i x_i^{*2}\right] & \text{if } q_i < q_k \end{cases} \tag{52}$$

with

$$\Delta R_i(X_i^*,\cdot) = \begin{cases} x_i^*(q_i - N_k\sigma x_k^* + (1-2N_i)x_i^* + (N_i-1)\sigma\widetilde{x}_k^*) & \text{if } q_i \geq q_k \\ x_i^*(q_i - N_k\sigma x_k^* + (1-2N_i)x_i^*) & \text{if } q_i < q_k \end{cases}, \tag{53}$$

$$\widetilde{F}_k^*(\cdot) = \frac{1}{2}\left[\widetilde{x}_k^*(q_k - \widetilde{x}_k^* + (1-N_i)\sigma x_i^* - 2N_k x_k^*) + c_i\widetilde{x}_k^{*2}\right], \tag{54}$$

$$c_i = \frac{q_i^2}{2\left(2-q_i^2\right)},\ \forall i = 1,2. \tag{55}$$

Using (55), for the equilibrium quantities x_i^*, $i = 1,2$, and $\widetilde{x}_k^*$, $k = 1,2$, $i \neq k$, we have

$$x_i^* = \frac{2c_k q_i + N_k(2q_i - \sigma q_k)}{4(c_i+N_i)(c_k+N_k) - N_iN_k\sigma^2} \tag{56}$$

and

$$\widetilde{x}_k^* = \frac{4c_k(c_i+N_i)q_k + 2(c_k - c_kN_i + N_k)\sigma q_i - N_kq_k\sigma^2}{2(1+c_i)\left[4(c_i+N_i)(c_k+N_k) - N_iN_k\sigma^2\right]}. \tag{57}$$